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especially deepened. This places them among the more primitive members of the genus, and hence would seem to indicate a Lower Jurassic horizon.

The distribution of American Devonian fishes was discussed with reference to those of other countries. During the Lower Devonian there was none, and in the Upper scarcely any intermingling of United States and Canadian vertebrate faunas, but those of Canada and Great Britain belonged to a distinct province. Corniferous fishes of Ohio and New York are most nearly related to those of the Middle Devonian of continental Europe, especially the Eifel, Bohemia, etc. The Hamilton faunas of New York and the Mississippian region, including Manitoba, are the direct successors of the Corniferous, but the Chemung of both eastern and western regions (or its equivalent) contains a remarkable mixture of indigenous types and intruders from all directions. Intercommunication between eastern Canada and Great Britain, Spitzbergen, etc., became general for the first time during this period. The transition between Devonian and Carboniferous faunæ is now known to be more gradual than was formerly supposed.

The only natural basis of family classification among *Arthrodires* was held to be through comparison of the sutures of cranial and dorsal shields, the differences in dentition being of only secondary importance. Degeneracy of the latter in *Titanichthys*, etc., is paralleled by that in certain toothless whales (*Mesoplodon*, etc.). Cranial osteology of *Homosteus* and *Heterosteus* compel their removal from *Coccosteidae* to form a separate family called *Homosteidae*. In this family the so-called antero-dorso-lateral corresponds to the like-named element in *Dinichthys* and *Titanichthys* plus the clavicular. The latter plate functioned as a support for the gills, and hence may be interpreted as a modified branchiostegal apparatus, but in

no sense as a part of the shoulder-girdle. There is no evidence that any of the *Arthrodires* possessed pectoral fins. The obvious resemblance of this group to Ostracoderms, with implied relationship, is lost sight of through its removal by Woodward to the Dipnoi, and there seems to be sufficient evidence for regarding the *Arthrodira* as a distinct sub-class, of equal rank with Lung-fishes, Teleostomi, etc., as already suggested by Dean.

CHARLES R. EASTMAN.

RAPIDITY OF SAND-PLAIN GROWTH.*

THE undisturbed character of the stratified deposits making up the sand-plains, taken in connection with the absence, or at most, the very slight development of constructional back-sets, indicates, as was early pointed out by Davis, a stationary ice margin during the period of deposition. It follows, therefore, that their formation must have been extremely rapid, and the natural conclusion is that they represent the deposits of a single summer's period of melting, an interval not over eight months in length.

It occurred to me that a calculation based upon the conditions now existing in the large glaciers of Alaska might give some indication as to the probability of such estimates, or at least would be of interest in this connection.

To make this calculation it is simply necessary to divide the bulk of the sediments by the daily discharge of detritus by the glacial stream which deposited them. This involves factors which are usually very difficult to determine, but at the sand-plain near the railroad station at Barrington, R. I., the conditions are almost ideally perfect, and admit of the determination with considerable accuracy of both the bulk of

* Abstract of paper read before Boston Society of Natural History, February 15, 1899.

the sediment and the size and velocity of the stream transporting it. Owing to the fact that observations as to the amounts of the fine clay-like detritus of glacial streams are more numerous and reliable than those upon the coarser material, the bulk of the contemporaneous clays was taken as a basis of calculation, rather than the sand-plain itself. In estimating the load of the glacial stream, I have taken the maximum value of 13 grams per liter, given by Reid for the Muir Glacier (the highest value on record), as the one which, in all probability, would most nearly correspond to the load of a glacial stream during the closing stages of the continental ice sheet.

At the time of the formation of the Barrington clays the land stood at a level of at least forty feet below that at present existing, and the deposition took place in an inclosed bay, having the ice sheet as its northern boundary, a ridge of till and modified drift for its eastern boundary, and an earlier sand-plain as its southern boundary. On the west was a broad and deep opening, connecting with Narragansett Bay, and admitting of a complete commingling of the salt and fresh waters. Into this inclosed bay flowed a stream with a width, as indicated by its esker, of 150 feet, a depth of some 20 feet, and an average velocity of not over 5 feet per second. On the assumption that the amount of sediment was 13 grams per liter, the daily discharge of clayey material would have been some 526,500 tons per day.

Experiments recently conducted by Professor W. O. Crosby in connection with professional work for the Metropolitan Water Board of Massachusetts, the results of which he has kindly placed at my disposal, indicate that material such as the clay beds are essentially composed of, *i.e.*, quartz-flour, settles with great rapidity, and it can be shown that practically the entire amount of sediment brought in by

the glacial stream must have been deposited within the inclosed bay described.

The clays cover about a square mile in area, have a maximum thickness of 60 feet, and a total bulk of 95,300,000 tons. Dividing this bulk by the daily discharge of sediment by the glacial stream (526,500 tons), the time of deposition of the clays is indicated to have been 181 *days*, or almost exactly six months.

The Barrington deposits probably represent very nearly average conditions; hence a period of six months seems a fair estimate of time for the formation of a simple sand-plain of moderate size. In the case of large plains, with areas of several or many square miles, the period of deposition may be considered as extending over more than one season of melting, there being in the meantime either no retreat of the ice margin or a retreat so slight that the intervening space was completely filled and the sand-plains united into a single compound plain.

MYRON L. FULLER.

PROPOSED SURVEY OF THE NILE.*

THE Egyptian government has agreed to undertake a survey of the Nile with the object of determining the species of fishes inhabiting its waters. It is due in the first instance to the efforts and energetic action of Dr. John Anderson, F.R.S., who has already done so much to enlarge our knowledge of the fauna of Egypt that this important project, to which so much scientific interest is attached, has now taken definite shape. A memorandum prepared by him, setting forth his proposals for the survey and the lines of his scheme for carrying it out, received the approval of Lord Lister, President of the Royal Society; Professor E. Ray Lankester, Director of the Natural History Departments of the British Museum; Dr. A. Günther, President of the Linnean Society, and Mr. P. L. Sclater, Secretary of the

*From the *London Times*.